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A MATHEMATICAL OPTICAL VIEWPOINT ON PRESBYOPIA*

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The above is a dangerous title, I know. It may be easily construed that the author tries to force a physiological phenomenon into the "Spanish boots" of a mathematical equation. Then the physiologists and psychologists will jump all over me because they hate mathematicians by instinct and training. So in order to appease my anti-mathematical brethren, I shall shortly outline the trend of my thoughts and procedure.

I did not build by means of slide rule, straightedge and square the mathematical housing first and then mutilated, squeezed and tampered with the clinical data until they fit the mathematical housing; on the contrary I did just the opposite. For many years have I observed certain near point muscle phenomena in presbyopes, and not satisfied with my own experience I solicited throughout the length and breadth of the land the opinion of all practitioners who make those tests, and found that their experience, in the vast majority, concurs with my own. Furthermore shall I try to check my mathematical assumptions against the maximum and minimum physiological probabilities and always leave a comfortable margin either way. Never shall I be understood to give to a near point muscle finding an absolute digit such as 6^{Δ} or $6\frac{1}{2}^{\Delta}$ and to denounce as abnormal any variation from this digit. Thus I hope to escape the accusation of tampering with physiologic facts, and if I must be accused of tampering it can only be of tampering with mathematics.

The following observations are most common in presbyopes,

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namely: A high exophoria at 13″ and a low recombination point from adduction at 13″. The subjective symptom in many presbyopic cases is discomfort for reading at any length of time and particularly at the end of the day. In order to be sure that the readers and I talk the same language, I shall in short repeat the technique of the test.

The muscle test at 13″ is made with the patient wearing his or her near correction, therefore, the non-presbyope wears distance correction and the presbyope wears near correction. My procedure to take the phoria test at 13″ follows Sheard's suggestion of phoria testing by means of disassociation. The target consists of a single horizontal line of small print. Use 6Δ b. up over left eye (or 3Δ b. u. over left and 3Δ b. d. over right) and determine how many prism dioptries base in over right eye are needed to bring both images plumb over one another. This then gives the exophoria at 13″. The technique of this test may vary, important in only that the accommodation for 13″ is in use. Supposing the patient is orthophoric for distance, then the exophoria at 13″ signifies the amount of convergence which is to be supplied by his fusion urge (fusional convergence) while 18°— EXO at 13″ (taking 60 mm. P.D. as the basis for our calculation) constitutes that part of the convergence which is supplied by his accommodative effort, the accommodative convergence. The test for the recombination point from adduction at 13″ is done with a vertical small print line as target. The rotary prisms are turned simultaneously base out until a breaking of the line in two lines occurs, the prism amount then indicating the relative positive fusional reserve or adduction at near. With this over abundance of prism base out before his eyes the patient then experiences heteronymous diplopia. The prisms are then gradually reduced, thus bringing the two vertical lines closer together until they snap again into one single vertical line. The prism amount with which this happens is then the positive recombination point at 13″ or as I like to call it the extent of the positive fusional reflex field. It is generally conceded that for comfort at near the recombination point should be located as far on the positive side of the 13″ fixation as the exophoria at near shows a tendency for a divergence of the eyes to the negative side. An approximate minimum amount is 4° to 6°. The normal exophoria at 13″ (always assuming orthophoria for distance) is anywhere around 4° to 8°. So when a recombination from adduction occurs at 6° to 10° or more prism base out we have all reasons to expect muscular binocular comfort at reading distance. An increase in the amount of near exophoria necessitates for comfort's sake an increase of the reflex fusion field. If the near exophoria increases gradually and not to any great extent, then I can perceive that the fusion field will also gradually extend, thus meeting the additional demand. However, when this increase of near exophoria is comparatively sudden and large, then the extension of the fusion field cannot keep step with the additional demand. The

recombination point will be dragged more towards the zero mark and may even become negative (recombination at prisms base out) and single binocular fixation will become a conscious effort, thus bringing discomfort with prolonged near point work. These above remarks are to my best knowledge and belief universally accepted as true conceptions.

We shall now proceed and shall look with the eyes of a presbyope thru his reading correction. In order to have a normal condition to which we may refer the phenomena observed, we shall first make an investigation of the accommodative convergence and fusional convergence relationship existing in a pair of young emmetropic eyes. When this emmetrope looks at 13″ and obtains sharp single binocular vision he uses of accommodation 3 diopters and of convergence 3 M.A. of 18° (P.D. = 60 mm.). These 18° of convergence will be supplied by two sources, namely, the accommodative convergence and the fusional convergence. The existing relationship between these two functions has clinically been established as normally about 2:1. Thus we shall have an accommodative convergence of about 12$^{\Delta}$ and a fusional convergence (Exo. at 13″) of about 6$^{\Delta}$. Then we have the law that normally 3 Dio. of accommodation supply 12$^{\Delta}$ of convergence or if this is a straight proportion 1 DIO. ACC. supplies 4° of convergence. If this straight proportion clinically holds true has been up to the present time, investigated rather perfunctorily and in only very isolated cases. Within a year we shall have a definite answer, as this task has been assigned to this year's program of the physiological optical research work of the Pennsylvania State College of Optometry. Diagram No. 1 has been calculated on the principle that 1 DIO. normally supplies 4° convergence.

Diagram No. 1: The horizontal line gives in inches the fixation distance; the vertical line gives the total convergence, the accommodative convergence and the fusional convergence for the various fixation distances. The accommodative convergence = total convergence — fusional convergence. The upper curve terminates the total converge while the middle curve separates the accommodative from the fusional convergence. Let us now investigate to what degree this diagram will conform with yet lacking clinical data. The upper curve of total convergence cannot change one iota because it simply is a factor of the fixation distance. The middle curve may be slightly modified but even this is very unlikely. At infinity the curves must meet the X axis asymptotically because with total convergence = O the accommodative and fusional convergence are also = O. If we would assume the middle curve as a straight line it would have to run parallel to the X axis which is unthinkable. If we would assume the middle line as convex instead of concave the curve would have to change at some point to concavity in order to fulfill the asymptotic condition at infinity. This turning point in the curve could only be brought about by a third physiologic function other than accommodation and

FIXATION	TOTAL CONV.	ACC. CONV.	FUS. CONV.
13"	3 M.A = 18$^{\Delta}$	12$^{\Delta}$	6$^{\Delta}$
16"	2½ M.A = 15$^{\Delta}$	10$^{\Delta}$	5$^{\Delta}$
20"	2 M.A = 12$^{\Delta}$	8$^{\Delta}$	4$^{\Delta}$
25"	1⅗ M.A = 9.6$^{\Delta}$	6.4$^{\Delta}$	3.2$^{\Delta}$
30"	1⅓ M.A = 8$^{\Delta}$	5.3$^{\Delta}$	2.7$^{\Delta}$
40"	1 M.A = 6$^{\Delta}$	4$^{\Delta}$	2$^{\Delta}$
∞	0 M.A = 0$^{\Delta}$	0$^{\Delta}$	0$^{\Delta}$

CALCULATION FOR FIG. 1.
TABLE 1.

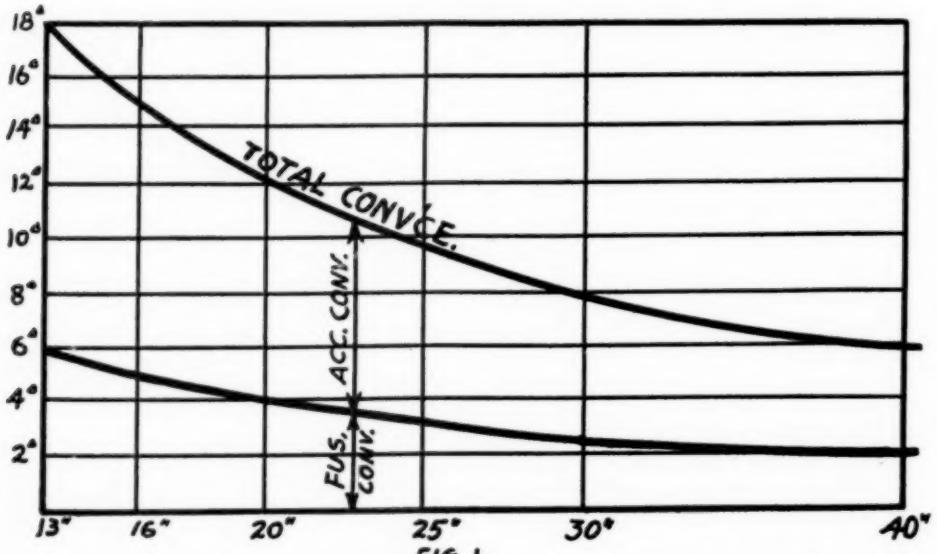


FIG. 1.
RELATIONSHIP BETW'N ACC. CONV. AND FUS. CONV. AT VARIOUS FIXATION DISTANCES EMMETROPE LESS THAN 35 YEARS OLD.

convergence which to our present knowledge is equally unthinkable. I can therefore safely predict that the research investigation will verify the curve as shown where deviations of 1° to 2° either way will not change the characteristic of the diagram.

The main characteristic of the diagram shown in Fig. 1 is that with a recession of the fixation point goes a decrease of accommodation and total convergence. Furthermore with a diminishing accommodation and total convergence we also have diminishing accommodative and fusional convergence and last but not least the normal proportion of 2 (Accom. Conv.) to 1 (Fus. Con.) is generally mainained throughout the entire recession of the fixation point from 13″ to infinity.

Let us turn our attention now to the presbyope who has been fitted with the proper addition. Under proper addition we understand so much additional plus power that not more than one-half of the patient's amplitude of accommodation is in use when he is working at his habitual near point. Example: A man of 50 years with a habitual working distance of 13″ would need an addition of + 1.75 Dio. His total amplitude is 2.5 Dio., one-half of his total amplitude is + 1.25 Dio. which has to be augmented with add + 1.75 Dio. to bring about comfortable vision for 13″ = 3 Dio. If his habitual working distance is 16″, then his addition would be + 1.25 Dio. Let me say here that I am absolutely and irrevocably opposed to an addition for a working distance of 13″ and that I always preached and will continue to preach to determine the addition for reading distance of 16″ and even more. If I use in this little writeup the near point distance 13″ it is only in order to be able to refer to the phoria test made at 13″ and to compare with the normal condition which is established clinically for 13″.

The primary question that presents itself relative to a presbyopic correction is, what is the range of the patient's vision looking thru the uppers and what is this range looking thru the lowers of his presbyopic glasses? In other words, we shall determine the P. P. and P. R. for the distance as well as the reading corrections. This has been done for the age from 40 to 70 years, taking as a basis Donder's amplitude of accommodation table and a chosen working distance of 13″ as well as 16″. The mode of calculation is shown in Table 2 for a working distance of 13″ and the years 50 to 70. Fig. 2 shows graphically the results of this calculation. We are confronted with one notable fact. A presbyope beyond the age of 52½ years and corrected for a working distance of 13″ faces an area of blurred vision which cannot be cleared up by looking thru his uppers on account of lacking accommodation and neither can it be cleared by looking thru his lowers because it is beyond the far point of his reading correction. The only means of bringing points within this area to form an image on the retina is then to shift the position of the head forward or

backward. For example this area of blurred vision for a presbyope of 60 years of age corrected for a working distance of 13″ extends from 16″ to 40″. The 16″ he can reach thru his lowers by complete relaxation of his accommodative and the 40″ thru his upper and full use of his accommodative amplitude of 1 Diop. The range for his near vision thru his lowers extends from 11½″ to 16″ where the lower value can be reached by stressing to the utmost his depleted accommodation and the upper by completely relaxing the same. When the addition is computed for a working distance of 16″ then the condition becomes slightly better. See Table 2, Figure 2.

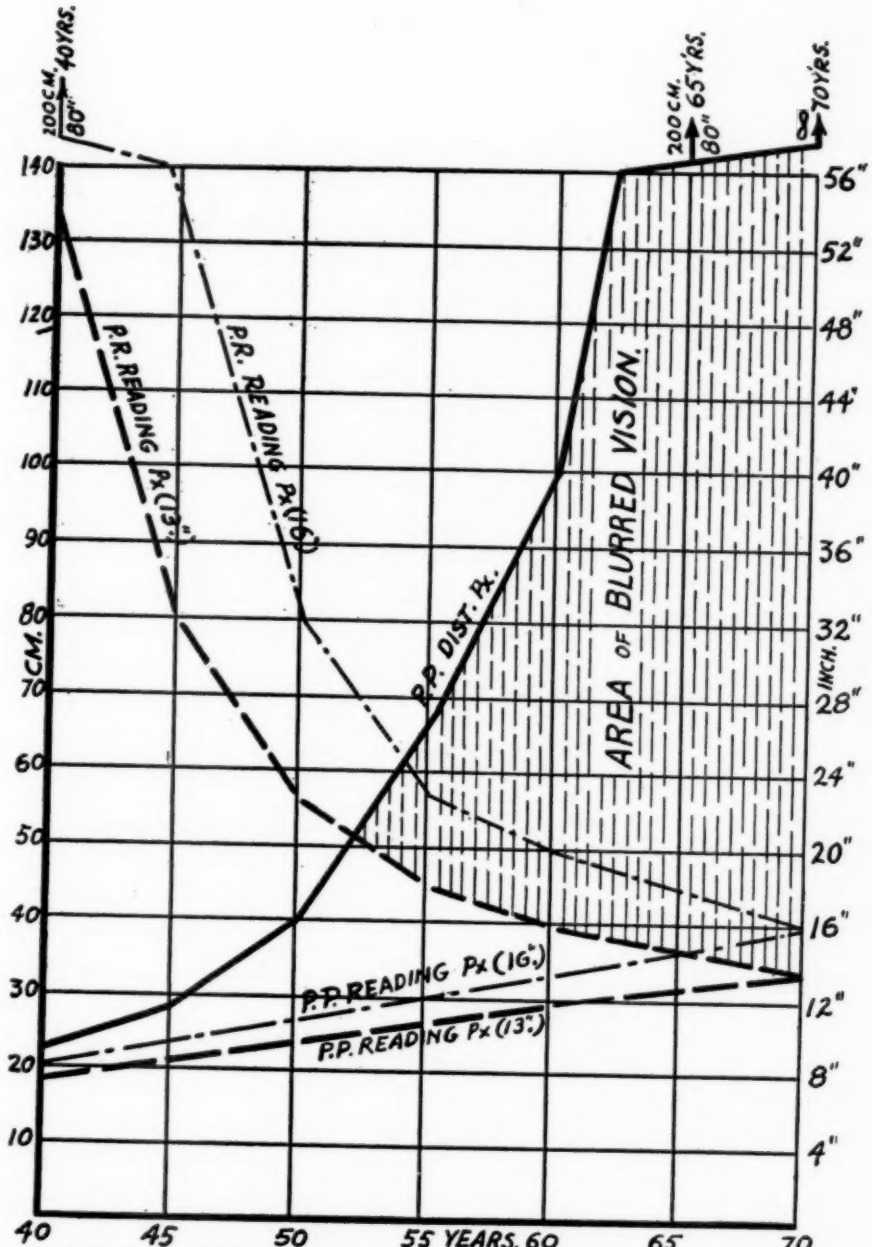
AGE.	AMPL. OF ACC.	C.M. P.P. THRU UPPERS.	INCH. P.P. THRU UPPERS.
50	D. 0. 2.5	C.M. 40	INCH. 16″
55	1.5	66.7	26.7″
60	1.0	100	40″
65	.5	200	80″
70	.0	∞	∞

P.P. AT PRESB'C AGE

AGE.	TOTAL AMPL. OF ACC.	½ TOTAL AMP. OF ACC.	ADDITION FOR 13″	TOTAL AMP. + ADDITION.	C.M. P.P. THRU LOWERS.	INCH. P.P. THRU LOWERS.	C.M. P.R. THRU LOWERS.	INCH. P.R. THRU LOWERS.
50	2.5 D	1.25 D	1.75 D	4.25 D	cm 23.5	9.4″	cm 57	23″
55	1.5	.75	2.25	3.75	27	10.75″	44	17.9″
60	1.0	.50	2.50	3.50	28.5	11.5″	40	16″
65	.5	.25	2.75	3.25	31	12.1″	36.2	14.5″
70	.0	.0	3.00	3.00	33	13″	33	13″

NEAR AND FAR POINT THRU PRESBYOPIC ADDITION.
TABLE 2.

Up to now we have only taken the accommodation into consideration regarding the disadvantages encountered by the corrected presbyope. Let us turn our attention now to the convergence, and determine how they are affected by the bifocals. In order to be able to calculate we have to make certain assumptions. It is generally conceded that as long as the accommodation in use does not exceed ½ of the total amplitude, the physiologically normal hookup between Acc. Con. and Fus. Con. of 2:1 is preserved. A presbyope (working distance 13″) uses for 13″ one-half of his total accommodation and therefore his accommodative convergence is the same as that of a young



RANGE OF ACCOM. WITH DISTANCE AND READING Px.
READING ADDITION FOR 16" —·—·—
READING ADDITION FOR 13" — — —
FIG. 2.

person looking at 13″ thru distance glasses. An example will suffice. A presbyope of 60 years has an accommodative amplitude of 1.0 Dio. corrected for 13″ working distance he uses, looking thru his lowers, at 13″ one-half of his accommodation, namely, .5 Dio. This accommodative effort should supply him with an accommodative convergence of 12Δ, just the same as an accommodative effort of 3 Dio. will supply a 33-year-old emmetrope with an accommodative convergence of 12Δ. In either case the used accommodation amounts to one-half of the total. Truly the absolute values differ considerable, being in the 60 year case one-half diopter and in the 33 year case 3 Dio. The innervational effort in either case, however, is identically the same, the difference manifesting itself only in the accomplished results on account of the age sclerotic condition of the 60 year old crystalline lens. As we do not have a sclerotic condition of the internal recti we will therefore receive the same accommodative convergence with 60 years as we had with 33 years with the same innervation of ½ of the total amplitude . Thus we can rightfully expect the same exophoria near point findings for non-presbyope (below 35 years) looking thru their distance correction and presbyopes looking thru their reading correction. The starting point of 13″ in regard to accommodative convergence and fusional convergence is therefore the same for presbyopes and non-presbyopes using their reading or distance correction respectively. As soon as this fixation distance increases beyond 13″ we shall find a considerable difference in the relation between accommodative and fusional convergence of the two groups. Returning to Fig. 1 we find that with the recessation of the fixation point a gradual diminution of the accommodative convergence and fusional convergence is experienced by the non-presbyope and that the approximate ratio of 2:1 of these two components is preserved. Entirely different conditions prevail in the case of the corrected presbyope. Turning our attention to Table 3 and the accompanying Figures No. 3a, 3b, 3c, 3d and 3e we find the line dividing accommodative convergence from fusional convergence just runs opposite in character to the established norm of Figure 1. Let us cite one example: A 60-year-old presbyope is corrected for 13″ working distance. At 13″ fixation he uses ½ Dio of accommodation (½ of his accommodative amplitude) and receives an accommodative convergence of 12°, disclosing 6° Exo. at 13″ (orthophoric for distance). The fixation distance shall now increase 2″, directing his gaze to 15″. This distance expressed in M. A. and Dio. is equal to $^{40}/_{15} = 2\frac{2}{3}$ M. A. and $2\frac{2}{3}$ Dio. respectively. The total convergence is then $2\frac{2}{3} \times 6 = 16°$. His accommodative effort to focus upon 15″ is $2\frac{2}{3}$ Dio. less his addition, 2½ Dio. equal to 1/6 Dio. An accommodative effort of ½ Dio. (half of his total amplitude) has supplied him with an accommodative convergence of 12° and we may expect that an accommodative effort of 1/6 Dio. will proportionately supply him with an accommodative convergence of 4 prism diopters, leaving 12° to be supplied by

fusional convergence. It is, of course, not necessary to calculate all the intermediate distances. It suffices only to start at the working distance of 13″ (presbyope using ½ of his amplitude of accommodation) and calculate his far point for reading correction. For this far point his accommodation is nil and the total convergence must then be covered by fusional effort.

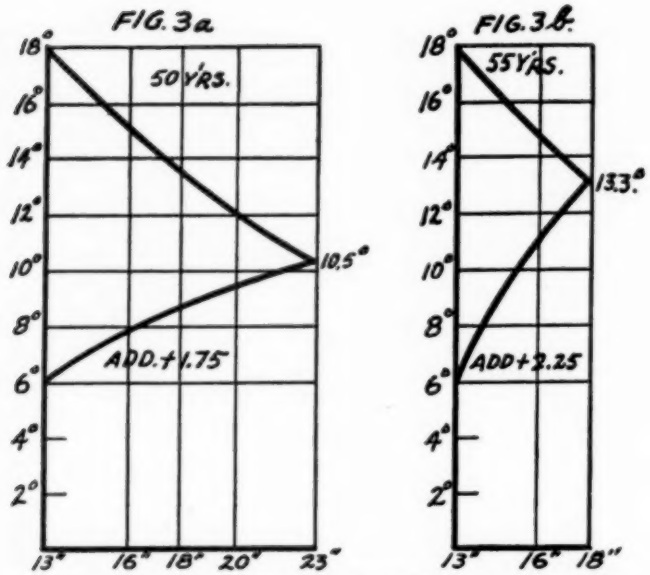
AGE.	FIXATION THRU LOWERS.			FIXATION THRU LOWERS. (P.R.)		
	DIST.	ACC.CON	FUS.CON	DIST. P.P.	ACC.CON	FUS.CON
50	13″	12Δ	6Δ	23″	0	10.5Δ
55	13″	12Δ	6Δ	17.9″	0	13.3Δ
60	13″	12Δ	6Δ	16″	0	15Δ
65	13″	12Δ	6Δ	14.5″	0	16.6Δ
70	13″	12Δ	6Δ	13¼″	0	18Δ

RELATIONSHIP OF ACC.CON. AND FUS.CON. AT VARIOUS FIXATION DIST'S LOOKING THRU PRESB'C. ADDIT'ON.

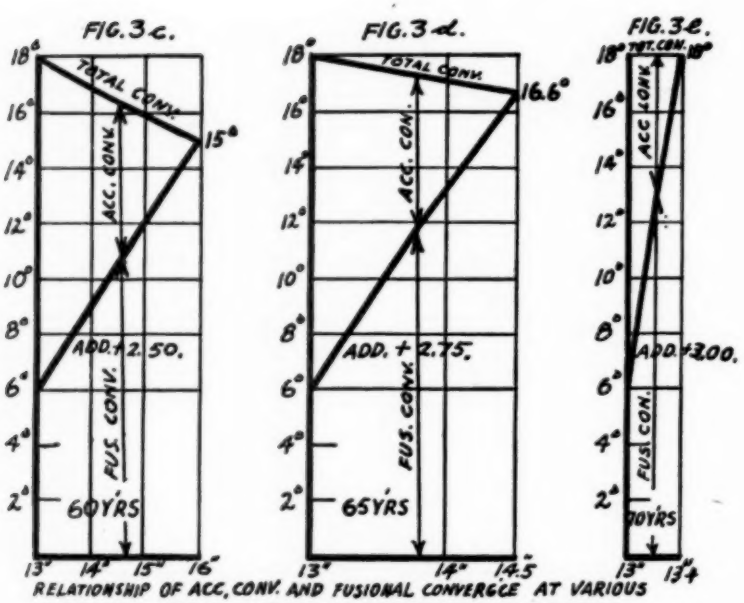
TABLE 3.

The most striking characteristic of this investigation is that the fusional convergence demand for the presbyope at distances greater than the working distance is increasing instead of decreasing.

Before we discuss the consequences of this peculiarly abnormal set up we shall discuss the probable incongruities of these diagrams with the clinical physiological experiences. The far point of the read-



RELATIONSHIP OF ACC. CON. AND FUS. CON. AT VARIOUS FIX'N. DISTANCES LOOKING THRU. PRESBYOPIC ADDITION.



RELATIONSHIP OF ACC. CONV. AND FUSIONAL CONVERGCE AT VARIOUS FIXATION DISTANCES LOOKING THRU PRESBYOPIC ADDITION.

ing correction is a purely mathematical property. At this fixation there can not be any accommodation and therefore there can not be any accommodative convergence. The fusional demand at the reading far point must be unquestionably granted. Then the only point that remains to be discussed is the distribution of accommodative convergence and fusional convergence at the working distance with ½ amplitude of accommodation in use. The normally accepted version for this condition is the proportion of 2:1 for accommodative convergence to fusional convergence. The only admissible argument is that it will be less than that 2:1 ratio on account of the numerically lesser accommodation. Although this argument does not tally with the general physiological conception it is at least conceivable. Inconceivable, however, is that a numerically less accommodation, though proportionally the same as in non-presbyopes, should bring about more accommodative convergence in presbyopes. Remains therefore only the chance that the accommodative convergence should be less than shown in diagram 3a to 3e which chance would make conditions worse than shown. One point of argument may be that no experienced optometrist will test and supply the addition for 13″ working distance but will invariably choose 16″ the working distance. This point is well taken and must be granted. If the calculations and diagrams were made for 16″, then the far point for the reading would shift slightly further out, but the characteristic of the dividing line between accommodative convergence and fusional convergence will not change.

There may be, however, a few well taken objections from the physiologic and psychologic side of the phenomenon under consideration. The first objection is physiologic and says that the accommodative and convergent faculty cannot be considered as absolutely independent faculties but on account of their very close relationship are to be considered interdependent. We cannot conceive a 60-year-old presbyope looking at the far point of his reading correction, i. e., 16″ (his working distance is taken at 13″) and applying for the sake of single binocular vision 2½ M. A. without having an accommodative impulse and with it accommodative convergence. It is not necessary that this accommodative impulse must bring about actual accommodation. Another objection of physiologic nature may be the question of accommodative effort. It may be said, and rightfully so, that the accommodative impulse does not follow a straight proportion. A presbyope may use a certain percentage of innervation of the available total for the first third of his total amplitude, one and one-half as much for the next third and three times as much for the last third. Such a distribution would serve to the better, because this "percentually" increased effort would surely supply a larger amount of accommodative convergence as shown in the diagrams 3a to 3e.

Another objection of psychologic nature may be attached to the

fact that single binocular vision at 16″ constitutes near vision no matter if this fixation distance is the far point of the reacting correction of a 60-year-old presbyope. This sense of nearness of the fixation point will set off an accommodative impulse. Even though this impulse will not bring about an actual measurable accommodation, it surely will effect accommodative convergence, thus lowering the demand upon the fusional demand.

It is deplorable that actual clinical data covering these objections are totally lacking. Granting them all, they will tend to modify the diagrams 3a to 3e but they will not rob them of their characteristics. With a recession of the fixation from working distance the fusional demand will increase while the accommodative convergence will decrease with presbyopic correction just opposite to the conditions existing in a non-presbyopic correction.

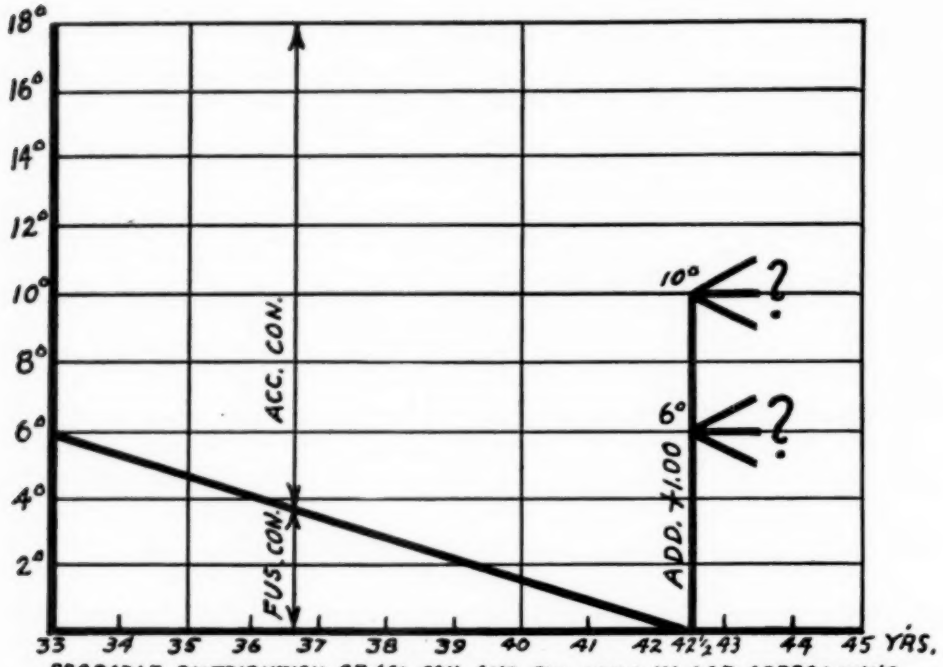
The expected consequences of such a reversed condition of things will surely not tend to comfort for the presbyope. Up to this time in life it has always been that a greater reading distance will make convergence easier and now quite suddenly he has to forget a life's training and learn anew. Up to this time he may have been perfectly able to cope with the exophoria at near by virtue of his fusion field and fusion urge especially as this exophoria at 13″ constituted the maximum demand. Now, however, this exophoria at near is the minimum demand and is increased rapidly within the space of a few inches to 11°, 13°, 15°, and 17°, depending upon his age. Naturally as his exophoria at near increases, his recombination point value decreases under this load. The only safety lies in an increased fusion field. A number of presbyopes will be able to meet this demand without any further help than their own robust fusion faculty. A goodly number, however, will be mighty uncomfortable and this number is much larger than the purely subjective complaint would indicate. Just to which class a patient belongs, depends upon many factors and particularly upon the employment of ocular remedies. About these remedies later.

Let us now consider the accommodative convergence relation as it may be deduced from the mathematical and physiological point of view during the 7 to 10 years preceding presbyopia. Again this consideration is reduced to the 13″ working distance although, I cannot often enough repeat, to correct for a working distance of 13″ instead of 16″ is utterly impractical. At 33 years of age we command an amplitude of accommodation of 6 Dio., of which 3 Dio., i. e., one-half of the total is used for clear vision at 13″. Under this circumstance we may expect a normal accommodative convergence of 12$^{\Delta}$, revealing therefore an exophoria of 6$^{\Delta}$ at 13″ (orthophoria for distance). From this time on the accommodative demand for 13″ fixation surpasses the 50% comfort margin of total amplitude and it would not at all be surprising to find a great accommodative convergence and therefore less

exophoria at 13″. This usually holds true in many cases. Logically then the near exophoria would diminish and with it the fusional demand. This condition may be carried to such extent that at an age of 42½ years we observe orthophoria at 13″ and consequently there is no need for any fusional effort. At this time the accommodative amplitude is about 4 Dio., of which 3 Dio. or 75% (instead of 50%) is used for fixation at 13″. It stands to reason that this relatively greater effort will supply a greater accommodative convergence. Most certain is this condition when the patient has to do minute detail work during this period and cannot counteract this development by a greater fixation distance on account of the then diminished retinal image. At 42½ years of age the need of a reading addition becomes imperative. In keeping with the rule to keep ½ of amplitude of accommodation in reserve we supply a reading addition of + 1.00 for a working distance of 13″. (Total amplitude of accommodation, 4.00 Dio.; ½ of amplitude = 2 Dio.; 13″ — 3 Dio.; Add. = 3 — 2 = 1 Dio.) As soon as this addition is applied a relaxation of the accommodative convergence takes place. There are two ways of reasoning permissible. With the addition of 1 Dio. the former status of ½ amplitude of accommodation in reserve is restored. With this the normal accommodative and fusional convergence relationship may be restored and we may find for 13″ looking now thru the lowers 12° accommodative convergence and 6° fusional convergence (exophoria at near). Or we may reason that the contribution of accommodative convergence per diopter of accommodation depends whether this is the first, the second or the third diopter of accommodation. I can conceive that the contribution of accommodative convergence per diopter of accommodation is about alike (4°) within the range of comfort (½ amplitude of accommodation in reserve), but as 1 Dio. of accommodation beyond that point constitutes a much greater innervational effort it will contribute more than 4$^{\Delta}$ of accommodative convergence. When this last diopter of accommodation is then relieved it may happen that a good many more than 6$^{\Delta}$ of accommodative convergence will be converted into fusional convergence. At any rate we may expect and usually find a relative increase of exophoria at near (Fig. 4).

As soon as the first bifocals are now fitted a reversal of fusional demand takes place. Referring to the first part of this article we have shown that fixation distances between P. P. and P. R. of the reading correction demand more fusional activity instead of less.

Referring to Fig. 4, I must admit that this diagram is the most speculative one of all. It may and does happen that this surplus demand of accommodation during the years preceding presbyopia brings about a fatigue exophoria at near very much similar to the fatigue exophoria at distance in an uncorrected hyperopic non-presbyope. In this case the addition will remove the fatigue factor and thus decrease this near exophoria.



PROBABLE DISTRIBUTION OF ACC. CON. AND FUS. CONV. IN AGE APPROACHING PRESBYOPIA- FIXATION DISTANCE 13".
FIG 4.

Let us now condense all these foregoing considerations into a few sentences.

1. Somewhere on the road from 34 to 44 it is necessary to apply more than one-half of the total amplitude of accommodation.

2. This generally will have a tendency to increase the accommodative convergence, thus decreasing the exophoria at near. This tendency, however, may be modified by working habits and other individual physiological factors. The actual status in each individual case can only be established by test.

3. The patient will usually enter upon the presbyopic state with a low exophoria at near. For years there was little demand on his fusion faculty at near and consequently his positive fusion field may have shrunk.

4. With the employment of reading addition we have immediately a release of the accommodative convergence which will show as an added exophoria at 13". This exophoria at 13" asks for neutrali-

zation by fusion action of a depleted fusion field (see statement No. 3).

5. To make matters worse this fusional demand increases rapidly as soon as the fixation object moves beyond the working distance.

6. The presbyope's near point vision is limited between the P. P. and P. R. of his reading correction. Beyond about 54 years there is a very definite area of blurred vision located between the P. R. of his reading correction and the P. P. of distance correction.

It may be said that in general the presbyopes are not complaining to one hundred per cent as this article may lead us to believe. There are of course presbyopes whose naturally well developed fusion sense will carry them over these obstacles to comfort, but I make the well founded claim that 50% of them are mighty uncomfortable at prolonged desk work. Many will not complain, thinking this discomfort to be another punishment of advancing age and those who do complain are told by many refractionists that it is a punishment of advanced age.

The main question, however, is: "What are we going to do about it?"

To begin with the sixth point first. The only thing we can do to extend clear vision beyond the P. R. of the reading addition is by fitting trifocals. Trifocals, in my estimation, are bound to come into general use beyond the age of 57 years. Not only would they serve to remove or at least reduce considerably the "area of blurred vision" but they also would tend to modify the accommodational and fusional convergence problem.

The test for positive fusional amplitude should become particularly significant during the years 37 to 42½. Where the positive fusional reserves and the recombination point at 13″ are low, fusion exercises should be instituted. These prism base out exercises are to be given at infinity (Well's stereo-phorometer with + 10.00) in order not to increase the already high accommodative convergence for the near point.

After bifocals have been fitted and a high exophoria at near with a low positive fusional reserve is in evidence, prism base out exercises should be given at the near point (Well's stereo-phorometer + 10 less (3+ addition) if corrected for 13″ or + 10 less (2½ + addition) if corrected for use 16″) for building up the fusional reserves and, if possible, the accommodative convergence reflex.

From the refractive standpoint there is particularly one teaching to be deduced from the foregoing consideration, namely: Avoid too great an addition. Don't test for the reading correction at a distance of 13″ but at least of 16″. Move the P. R. and P. P. of the reading

correction out and not in. By doing so the area of blurred vision will be reduced and the accommodative convergence increased.

Another corrective help is special reading glasses with prism base in, particularly for prolonged reading at evening. This would provide for a period of relaxation and thus reserve the fusional reserves for the working hours of the day.

When none of these helps will prove effective, the only solution lies in prisms base in on the segments only.

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IRIDOLOGY.*

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Indianapolis, Indiana.

The examination of the eye is primarily for the purpose of determining diseases confined to the eyes themselves. If further diseases are shown, the examiner immediately tries to determine the nature of further general medical advice required. From the refractionist's standpoint, a study of the iris is a most favorable differential diagnostic test.

The ophthalmoscope, for diagnostic purposes, reveals many hidden secrets with regards to general health, both past and present. This form of examination has always been accepted by all forms of medical research as being quite authentic. Practitioners both within the field of medicine and outside of the field of medicine, have resorted to this most enlightening study. It is interesting to check these diseases, which are revealed by the use of the ophthalmoscope and find that so little can actually be told from these tests or from the diseases thus revealed. Most authorities believe this is due to lack of proper instrumentation.

The ophthalmoscope reveals sugar or diabetic symptoms, but it does not tell what organs are most affected, or, the nature of the involvement, as accurately as a study of the iris. To state more specifically, it does not so accurately differentiate conditions of the liver, pancreas, or kidney. All we know is, that the patient should have some form of diagnosis, to determine just how severe the involvement is, and also more specifically locate the seat of the trouble.

If the ophthalmoscope reveals tuberculosis, it does not tell what lung or organ is most involved; and to go even a step farther, it does not locate the portion of the lung which is most affected; and yet the subject of ophthalmology has met with approval on all sides and the subject of iridiagnosis has been scorned and ridiculed by many of the leading students and thinkers in ocular research.

The diagnosing from the iris gives more specific information on the nature of the disease, the organs involved and the treatment needed, than any other form of ophthalmic examination known today.

I believe, the reason that diagnosing of health and disease from the iris has met with such rejection and criticism, is, that many unskilled practitioners have attempted to use it as a fortune teller

*An abridgement of the material presented before the American Academy of Optometry at Boston, Mass., Dec. 15, 1929.

uses the palm; or other known methods for predicting one's future and determining the past. Many of those interested in this form of diagnosis have been, and are at the present time, classed as quacks, and even reputable physicians who have taken up the study, have at times been classed with the quack and unskilled student.

I think one of the reasons this has happened, is that the one who criticised the work has not investigated far enough to know the full meaning of the markings and signs shown upon the iris. They may have taken up a study of the work and found that they could not prove things that were said in standard text books on the subject. This, I believe, was due to the fault of their interpretation of the iris observed, and material studied. Many times I have seen signs in the iris that did not coincide with diseases the patient had had in the past and was led to believe that the study was not altogether correct or complete; but later on, after further investigation, if I did so, the true meaning of the condition in the iris began to coincide with the history the patient recited. From the standpoint of a refractionist, we cannot afford to overlook the valuable material which can be compiled from the study of the iris of the patient whose eyes are being examined. It has been my experience that if the material or information gathered at the time of the refraction was not of value, that it oftimes became of great importance many months, or even years, later.

To the ordinary refractionist the location of diseases of the body as seen in the eye was of no particular benefit.

First, because of the fact that the patient came to have his eyes examined and did not care to be reminded or even insulted by the fact that his general health had any bearing upon his vision.

Second, if the diseases or abnormalities were located by the study of the iris, the refractionist was not in position to know where to refer the patient for further treatment; or if this patient had been referred to him from a diagnostician or physician, there was some hesitancy in suggesting what might be the patient's physical handicap.

Most refractionists do not hesitate to mention the diseases or physical conditions revealed with the ophthalmoscope; and in fact, even the physician referring cases often inquires as to the findings at the time of examination. To suggest to the family physician that the patient's eyes reveal that the lower right lung was infected, or, that the sigmoid flexor is highly inflamed, or, that the left ovary is inflamed; and that the eye revealed these conditions, is more than the ordinary physician can stand.

I have seen a lot of interest both with the patient and surgeon, as to what conditions are to be found within the abdominal cavity before the surgeon opened the patient to remove a supposed in-

flamed appendix. The iris itself tells these conditions to the point that in most every case where the iris shows, for instance a white line in the appendix region, the condition was pseudo appendicitis. If, on the other hand, there was a white triangle in the region of the appendix, surgical removal might be of value, but even then proper correction of the systemic toxemia by diet and proper flushing or irrigation of the large bowel would have given far more results in many cases.

We are all familiar with the case of appendicitis who never felt much better after the operation, possibly better for a few weeks or months and then the old symptoms returned. The rest in the hospital with the fasting and post operative diet, without the operation, would have given just as much relief from the symptoms.

The iris tells so many known conditions of health that the diagnosticians need not hesitate to reveal all of their findings even though same are unknown to the consultant, but this is not always advisable.

One of the most valuable ways to make a study of iridology useful, is to determine the major findings, summarize the case findings, and suggest that the patient have further examination of the specific lesions suggested and make no mention as to the source of your reason for making the suggestions. There are some cases in which the family physician may not be in sympathy with this iris form of examination or diagnosis; then it might be advisable to suggest that the ophthalmoscope or visual field test revealed reflex symptoms and it is highly possible that these symptoms were coming from certain organic defects; and yet, the true source of information came from the study of the iris, visual fields, ophthalmoscope, muscle and nerve tests. One must use discretion when applying the work to make it practical.

Most of the text-books written on the subject are written by men who do not believe in the advisability of drugs or surgery for the curing of diseases; and in these books they have made many harsh statements against drugs and surgery which did them more damage than good; and yet, they were trying to show by their discussion that nature's remedy was far superior. Nature's remedy no doubt is the best and most physicians are more reasonable than the text gives them credit for being. Remember the old saying, "Every knock is a boost."

To read some of these discussions is enough to turn one against the study of iridology; and it has created a great deal of hatred among noted physicians and surgeons, that would not have otherwise existed. (Many times in the study of these books one has to read a great number of pages of material to find the leading fact of interest described, simply because, the writer has interwoven so much

destructive criticism against other forms of diagnosis or treatment, that the fact relative to the disease and its treatment was practically forgotten.) Most of the books on the subject are not well organized, or they have been written in such a form that if one wishes to find signs, markings, and locations relative to a certain disease, they have to read the whole book to clear up the discussion. I can best illustrate this by the fact, that in trying to organize what one author for instance, has said upon involvement of certain parts of the body, twenty-five or even fifty pages had to be read, and when finally outlined and brought to a definite statement, it could all be said in one short paragraph. Most of the books written on the subject are nothing more than repetitions and remind one of discussions given in court by a lawyer who attempted to say the same thing as many different ways as possible; all of which is desperately confusing to the casual observer or even conscientious student. It gives too many possible ways of interpretation and the student begins to wonder just what is the real truth. Much actual observation of the iris in known cases of disease and injury is necessary to clear the discussions.

There is little difference or disagreement in the major facts relative to the subject as stated by the different authorities; and yet, as one reads the various texts, he is often led to believe that some other student or writer had an entirely different view on the matter. One text may give the subject more consideration from the standpoint of drugs and vaccinations, their ill effects, signs and markings, all of which is of much value to the refractionist and sometimes desperately confusing to the student; although even when determined, cannot be greatly helped and may be considered of little or no consequence by the physician to whom the refractionist refers the patient.

One author may try to show how these signs became so distinctly marked and to trace the nervous reflexes that caused the marks in the iris; and because another author did not attempt this analyzation, we may feel that he has a different idea on the subject. For instance, Lindlar states that operations performed under general anesthetic produce no markings upon the iris, because the sensory nerves are benumbed and paralyzed and do not respond to cause the reflex impulses, therefore, they were not recorded. Another author on the subject merely states that operations do not show; and still another states that they do. When the discussions are put together and analyzed, the operation under general anesthetic left no marking, but the drugs used in the wound showed their respective crude drug deposits. The disease which existed before the operation (if the part operated upon was diseased), still showed its markings in the form of destruction of tissues from the disease, and the destruction or removal of the parts concerned. These facts

prove that lesions in the eye are made through abnormal or pathological nerve impulses, which deranges the nerve fibers and other structures in the surface layers of the iris. This separation is unnatural and called the lesion or signs of iridology. Abnormal colors are signs also.

Analyzing this a step farther, one authority on the subject mentioned the fact that injuries or diseases of the brain are revealed in the eye on the opposite side upon which the disease existed while in other parts of the body they are shown on the same side. For instance, if the right hand was involved, the right iris showed the corresponding markings. The crossing of the optic nerves brings back the signs in the iris to the side of the body in which the corresponding lesion is located. Lesions in the brain cross over in the optic nerves, and show in the opposite iris. I believe to my knowledge, not all writers mentioned this fact.

To accurately locate these markings has always been very baffling and because the surgeon or anatomist cannot dissect the sympathetic nerve running from any one part of the body to the corresponding section of the iris in which the student of iridology calls the area for this particular organ or part of the body, the anatomist feels there is nothing to the subject, but this need not be discouraging. Think for a moment, if you please, what a desperate discussion and with what constant approval Donder's Theory of Accommodation and Convergence has met from many noted refractionists; and yet, only within the last few years have we known that the nerves controlling accommodation were in no way linked definitely with the nerves controlling convergence. It remains to the neurologist to explain the whys and wherefores of the signs shown upon the iris.

Most of the research done in the study of iridology has been done by clinical observation and comparison. The early examiner located lesions in the iris by observation of the iris after injury to known parts of the body. When he found enough corresponding injuries and lesions to establish the areas he thus divided into sections a chart, which we now call a "Key" to the diagnosis. We are much in need of differentiated diagnostic procedures and instrumentation to definitely locate the areas that we may have accurate comparisons. Photography and the Iridometer have been valuable assistants in this recording of findings. The Iridometer is an instrument of my own make and is used as a meridian finder.

Many people ask, "Just how long after the injury or disease will these signs remain? Is it possible that an injury which was received twenty years ago, or longer, could still show in the iris?" The answer is, things which have happened in the past always show either in the form of destruction of tissue, chronic disease, subacute inflammation, acute inflammation or a combination of two or more of these

stages of disease. There are some diseases which will destroy many of the long standing markings on the iris, but they will not destroy these markings unless they have eliminated the original disease or organ involved during some state of acute fever or inflammation or a natural unsuppressed healing crisis as it is sometimes called.

To give an example of this, we have a condition of scabies, which is a skin rash. If this skin rash is allowed to heal unsuppressed by drugs and the system expels the toxines normally, there will be no markings left upon the iris, although during the time of scabies, the lesion signs of acute inflammation were plain and well defined. If, on the other hand, the scabies was suppressed and driven back into the system by drugs, the iris will show that the disease has never been properly eliminated (see Fig. 1-C), and we will find that later on at some unexpected time the patient will break down with a disease of the organ involved or some other weakened organ of the body, which is another attempt of nature to expel the original scabies.

If the refractionist is located in the metropolis where referred cases are encountered, that have just previously been examined by one or more competitive eye specialists, and the patient has received no benefits; there are three methods of further investigation which I have always found of definite value.

They are:

(1) A complete study of the visual fields.

(2) A complete study of the functionation of the eye by means of the myologic unit and the fusion charts, etc.

(3) A study of the iris.

In checking a case history follow a set schedule as shown by a "Key Chart." The suggested steps given by the patient's case history, if the case history is properly taken, by constructive cross questioning and proper tabulation are worthy of consideration. In the examination of the iris it is necessary to use a chart or "Iris Key," at least until one becomes familiar with the location and size of the suggested areas. After some practice the examiner becomes familiar with the most prominent areas but an area finder is always a more advisable means of determination. The need for an accurate area determination led to my invention—the Iridometer. I believe that from such determination by proper instrumentation and case history, the examiner can determine almost without a falter the cause of the symptoms complained. I do not mean that because he has shown the cause of the symptoms that he does not need to make other optometric tests, but I do mean, that it is a good form of analyzation. If one chooses to take the study of the iris; first, he will find out what is physically wrong with the patient before making other visual examinations. This is not advisable, however, for the refractionist,

because he will soon become known as a iridiagnostician and much ability in lines in which he is well trained will be lost. The physical conditions may be the cause of the visual symptoms and the study of the iris should be used for this determination.

The work in my opinion should be only a part of the routine examination and you will find much to your surprise that the patient is more willing to pay for a thorough investigation, of not only the eyes, but his systemic symptomatic visual condition, than for a haphazard casual visual check and glass to magnify. The consultant and the examiner should be more interested in the causes of the visual symptoms and the possible physical reflexes.

I will not give much time or thought to the history and development of this work. Most every text gives a rather thorough outline of the stages in the development of this work. It might be sufficient to say, that it was discovered by Ignaz Peczely, of Hungary. While playing with an owl, he broke the owl's leg and noticed that a dark stripe showed in the lower regions of the iris. Later he noticed that this black streak became a tiny black spot around which white lines and shading were seen. This is the fundamental principle of all iris work. A beginner should always pay particular attention to the white signs and the dark signs. Peczely did not get to follow up this line of thought suggested by the owl until about 1861, when he treated his very sick mother and became interested in medicine at the age of 36. He first studied in Budapest in 1862. In 1864, went to Vienna; in 1866, he started practicing in Budapest and published his first book on the iris, "Discovery in the Realm of Nature and Art of Healing." This work was made known in Germany by August Zoeppritz. Dr. Emil Schlegel of Tuebingen, also published a book on the subject as a result of Peczely's book. Niles Liljequist, a Swedish homeopath, improved the methods of diagnosis and brought his work to this country where it was translated into two volumes, "Diagnosis from the Eye." The first volume is the descriptive material. The second volume is sketches and color plates of various irises as were described in the first volume.

Dr. Henry Edward Lane published his sixth edition in 1904, entitled, "Iridology the Diagnosis from the Eye." This text is out of print.

Dr. J. Haskel Kritzer has written a very splendid text-book of "Iridiagnosis and Guide in Treatment." This book is the one usually sold by book concerns.

"Iridiagnosis," by Lindlahr, Volume VI, of his natural therapeutic library is also a valuable reference.

"Disease Diagnosed," by Dr. F. W. Collins, in two volumes is also out of print. There are a few copies that can be had. It is a

translation of the work by Peter Johannes Thiel, in 1905, translated in 1918.

The only book or pamphlet that I have any knowledge of as having been written or translated by an optometrist was translated by Otto Hausman, Philadelphia, Pennsylvania, of the work of Dr. Emil Schlegel, of Tuebingen, Germany, "Ocular Diagnosis."

I have searched all over the country for books and material on the subject of iridiagnosis, and find that material on this most interesting subject is practically out of print. None of the publications have been a financial success, possibly the most successful, is the book by Kritzer, and the one by Lindlahr. That is, the author has not been financially benefited by writing on the subject, in most instances.

I have found hundreds of copies of the text, which I would consider one of the best written today, "The Diagnosis From the Eye," by Niles Liljequist, stored in a publishing house because the author and translator are unable to pay the publishing bill. The publisher has given me the authority to sell this text at $10.00 per set; and I would suggest those interested, secure these two volumes, because of their splendid material and illustrations. Write to my office, 5804 E. New York Street, Indianapolis, Indiana, and we will be very glad to furnish them. I do not mean to be advertising books, but because of the material being so hard to gather, and because of the value of these texts, I do not hesitate to tell you about them.

It was Dr. Niles Lidjequist who discovered the effect of vaccines and other drugs, such as quinine and iodine as they produced color changes in the iris. Dr. Liljequist showed the value of homeopathic medicine and the fact that medical deposits are not removable, ordinarily. He states that homeopathic medicine contains nothing but sugar, starch and water. In his work he points out valuable hints on diet, based on this fact. The experiences of Dr. Liljequist, from a general health standpoint, contributed greatly to his work on the subject as he watched his own health and the changes made in his own iris. He became very stern against all forms of drugs. In his work he made the statement that was once uttered by an Englishman, "With 40 years you are either your own physician or a fool." In Liljequist's work he has shown many interesting points of hygienic living that can be ably applied.

We will now turn to the practical work of diagnosing from the eye and will attempt to show the advantageous points of interest and how you may use them.

First of all the student must proceed systematically. He must not attempt to diagnose particular lesions or manifestations until he has learned to diagnose the general conditions of the body from the total impression of the eye. It is not advisable to use a magnifying

glass only in rare cases in the early part of the study. The first study should be made from observation of blue eyed individuals. The first steps of the observation should be to determine if the cornea is normal in color and clear. Observe the edge of the iris and its color for signs of scabies. Notice the mobility of the iris, size of the pupil, its color, its texture, its reactions to light, and other points relative to reflex.

The signs of the iris are best drawn. First draw all dark and black spots. Second, the catarrhal defects. Third, closed defects. Fourth, fresh white lines of inflammation. Fifth, medical signs or discoloration. This is the best way to get a good idea of the subject and a mental picture of the patient's condition. Diagnosis from the eye does not acknowledge so-called incurable conditions. The smallest marking seen in the iris may become manifestations of diseased tissues, if the power of the nervous system is too weak or the laws of nature stupidly violated. The beginner must be warned against hasty diagnosis. The signs can be only understood after much study and the constant comparison one with the other of the associations of the signs. Their relation one to the other and the fact that one sign may have developed as a result of a more major condition shown elsewhere, makes it necessary that much study be given the subject before making a conclusion. If you take time to draw what you see, you will naturally be directed to the association of signs. Color reproduction of the different signs is very difficult and is not advised unless one is a master at the work. Photographing the iris is not practical at the present time, as only the gross defects are shown. The great amount of light that necessarily must be thrown directly into the eye so that the high-light comes in the pupil area and thus does not come over some area or fiber of the iris, contracts the pupil and pulls the iris so that the lesions lose their normal size and shape. The colors are also lost. It is almost impossible to photograph the brown iris. I have made hundreds of photographs and only a few are true reproductions. It is advisable to draw sketches of the same iris at different times and compare the ideas or conclusions you have drawn. Photographs may be retouched to show the finer detail and by enlarging, make a fine study record. Examinations are made best by daylight, unless you have a steady point of light which has always the same amount of illumination, so that you become used to the various shadings and color changes. An accurate and careful examination is very fatiguing to both the examiner and the patient, without proper instrumentation, and requires many hours. However, with proper instrumentation, a five or ten minute observation will give much practical information. In trying to learn the subject, I have found one of the quickest ways is to dictate a description of the signs shown in the iris to a stenographer, as the observations are made, going systematically from one

position to another, describing the sizes, shapes, colors, and other peculiarities noticed. This dictated description may also be more profitable with the photographic record, as the stenographer's report gives the color and shapes undisturbed by unnatural photographic lights and reflections. I find that I uncover more detail by this method than if I attempted to sketch the iris or retouch a photograph. It also firmly fixes the material in my own mind and when I have done this, it is very easy to make conclusions and summarize the case. After you have made your conclusions and your summary, it is advisable to question the patient as a check on what you have found. Many times you will find that he does not agree with your findings, simply because the conditions seen are manifest in the eye long before they became noticed by the patient or you found signs of accidents, injuries, or diseases that the patient has long forgotten.

Some authorities, such as Lane, Liljequist, etc., make the following suggestions relative to sketches and drawings of the iris. First, use a lead pencil on white paper. The white places or signs of inflammation are best shown by sharply drawn or pointed black lines. Second, you might also use medium dark stipled and embossed paper, using a sharp knife as an engraver. This will give a more natural picture with more exact representation of the color signs. The key charts show the general plan of the card used. This gives you some idea of the area you are working with and a method of association of the lesions found in the drawing made.

A general examination of the eyelids, size of the pupil, its color, the color of the scleral and surrounding tissue, the condition of the eyelids, and a general observation as a preliminary external examination is helpful.

Consider the location of the part under study and its relation to the surrounding tissue. The iris is a colored membrane, circular in form, hanging behind the cornea, directly in front of the lens and in contact with it and perforated at about its center by an aperture of variable size, called the pupil.

In new born white children the iris is almost always blue. This is due according to scientists and anatomists to the fact that the pigment cells do not develop until sometime after birth, the true coloration not being complete until after the second year. In Albinos the pigment is entirely absent. The distribution of pigment varies greatly in different individuals, says Ketchem.

From a study of the iris or iridology, we consider the light blue and light brown as signs of normal health. A child may be born with a blue eye, but as toxins and diseased conditions, both exogenic and endogenic manifest themselves, the iris changes in color; many times becoming brown and darker. In such cases we consider the

changes in color an ill omen. In most books on the subject of iridiagnosis, one of the first chapters in the book is a discusion of the color of the iris both from a climatic and race standpoint. The various colors shown in the iris are points of much discussion. For the beginner, the consideration of the simple colors, seen as white and black signs will thus prevent much confusion. Later the color shading will become more easily recognized.

The following is a suggested color chart arrangement which enables one to get a better classification.

1. Clear blue.
   Whitish blue or whitish gray.
   Grayish blue.
   Inky blue.
2. Clear brown.
   Amber color or muddy brown.
   Dark brown.
   Roasted coffee brown.
3. Intermediate.
   Bluish brown.
   Brownish blue.
   Greenish cast.
4. Mixed color.
   Original color blue changed in parts due to crude drugs to brown.
   Blue changed in part to yellow or cat eye, orange.
   Brown changed in part to steel gray, brown or hazel.
5. Pink or Albino.

Brown color indicates encumbered blood, said by some to be short-lived, born with congenital weakness.

It is said that blood chemistry will give different analysis depending on whether the eyes are blue or brown. Also that the sense of smell will differentiate brown eyes from blue—as the brown eyed individual has an unpleasant characteristic body odor.

The diameter of the iris is from ten to twelve millimeters. Size of the pupil is considered a sign of weakness, if too large. The diameter ranges from three to six millimeters or more.

The blood supply comes from the two branches of the ophthalmic artery, known as the long posterior ciliary arteries, and the anterior ciliary arteries.

The nerve supply for the contraction of the pupil is through a branch of the third nerve which acts upon the sphincter pupillae encircling the border of the iris. Dilation occurs by relaxation of the sphincter pupillae and muscular contraction of the radiating muscular fibers. The dilator muscle is controlled by the sympathetic

nerves. The structure of the iris presents two chief layers; the stroma or body proper and the pigment layer. There are five layers listed, however.

1. Anterior endothelium.
2. Anterior boundary layer.
3. Vascular stroma layer.
4. Posterior limiting layer.
5. Pigment layer.

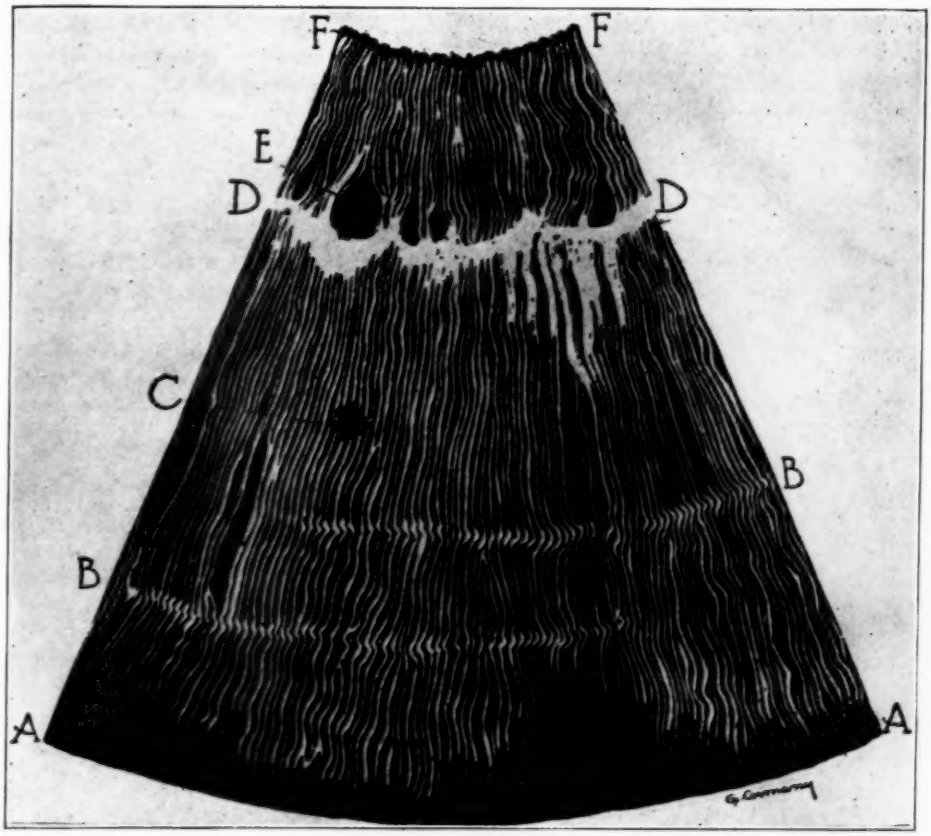
The vascular stroma layer, forming the bulk of the iris, consists of loose connective tissue supporting the numerous blood vessels and nerves which occupy this layer.

Fig. 1 gives a detailed view of the general density and texture of the iris. "F" is the pupillary border. Between "F" and "D" we find what is called the stomach and intestinal area. The white jagged line "D" is called the Arteria Circulus Minor (Minor Arterial Circle) when studying anatomy; but when studying the iris, we speak of it as the sympathetic nerve ring. The lines extending from "D" running toward the corneal scleral margin are called "Spokes or Radii Solaris." See Fig. 2, Sec. 4, dark cone-shaped spoke. These lines must not be mistaken for lesions. These lines indicate that the body is being poisoned from auto-intoxication. When the lines coming from the corneal scleral margin and from the sympathetic nerve ring meet, the patient's health is much impaired. Some iridologists do not pay much attention to the Radii Solaris, while others do.

The lines "A" extending from the corneal scleral margin inward are known as "Brooms." When discussing the corneal scleral margin of the iris from the standpoint of iridiagnosis, we speak of it as the "Scurf Rim." A scurf rim indicates the morbid matter as increasing in the body, due to lack of elimination through the skin and other organs.

Scurf rim is seen at "A." If the accumulation of toxin increases in the body, the scurf rim thickens and becomes heavier. It is in this region that we find the lymphatic rosary, a most interesting sign of the third and fourth stage of disease. Wherever the white flakes appear in this region they indicate inflammation and an engorged condition of the lymph nodes in the corresponding parts of the lymphatic system or in the later stage, an atrophic condition of the lymphatic glands. We must not confuse the lymphatic rosary and signs of arsenic. The lymphatic involvement appears only in the outermost rim of the iris, just inside the corneal scleral margin in orderly arrangement like beads of rosary, while the white flakes of arsenic may appear in singly or in irregular groups, anywhere in the outer half of the iris.

The white lines that are shown at "B" are where the iris folds when dilation of the pupil takes place. They may be light or dark.

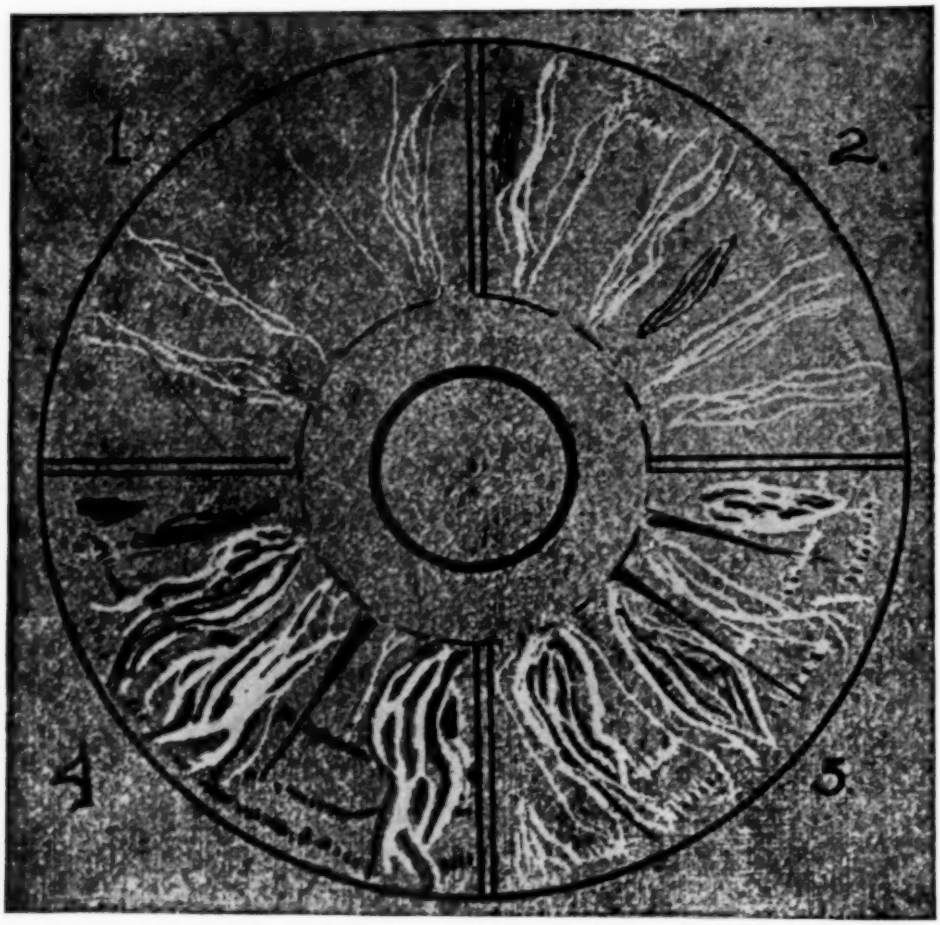


R. W. Bennett. Figure I.

and are described as concentric rings. These are called nerve rings or cramp rings, generally seen in the iris over the area which represents the organ affected or the organ which is causing the nervous over-strained or cramped condition. If the nerve rings completely encircle the iris, it is a sign of over-taxation of the nervous system. Dark nerve rings, Fig. 2, Sec. 4. White nerve rings, Sec. 2 and Sec. 3.

The little spot at "C" is a scabies sign. The separation of the tissue or stroma of the iris between "C" and "B" is a typical lesion sign. This separation may be any size, shape or color, depending upon the encumbrance of the organ involved. Open and closed lesions are seen also in Fig. 2.

Fig. 2 is a more detailed description of the differences in density seen; as caused by the compactness or separation of the stroma of



R. W. Bennett. Figure II.

the iris. Fig. 1 and Fig. 2 are taken from Lindlahr.

The color of the iris is indicative of hereditary traits and the purity or impurity of blood and tissues.

Density is a measure of that which we call vitality, tone, power of resistance, recuperative power, etc.

When the structures composing the stroma and surface layers on the iris are normally developed and arranged in orderly manner so that they lie in smooth, even layers, like the fibers in a perfectly woven fabric, and when the layer of endothelial cells covering the surface of the stroma is intact, the iris is of normal density and

presents a surface of crystalline clearness with the beautiful glossy appearance of topaz or mother-of-pearl.

When the iris shows a defective density the nerves and muscle fibers are unevenly developed and arranged, some swollen, others sunken or obliterated, crooked, warped, and intermingled. In some areas the fibers are massed into bundles, in other areas they are entirely displaced so that the darker underlying layers become revealed, giving the appearance of dark shadings and black spots.

In some instances the displacement is so deep that actual holes are formed exposing the dark pigment layer. This is often the case after serious wounds and fractures entailing great loss of, or injury to, tissues. Such a hole in the iris was the dark spot in the owl's eye which led the boy Peczely to discover the science of iridology.

An iris of defective density presents in color, as well as in grain and texture, an uneven, mottled appearance. As every sign, mark or discoloration in the iris stands for some condition in the body, it is clearly seen that defective density indicates lowered vitality and weakened resistance. In other words the degree of density of the iris corresponds to the degree of vitality and the general tone of the system. Since density refers only to the woof of the iris; the scurf rim, medicine signs, lymphatic rosary, and itch spots are not taken into consideration in determining the degree of density.

Since abnormal color pigments in the iris represent encumbrances of morbid and foreign matter in the system, and since density denotes the degree of integrity and tone of the tissues, color and density combined indicate the degree of:

(a) Stamina and endurance;
(b) Vital resistance to disease;
(c) Recuperative power and response to treatment;
(d) Expectancy of life.

We judge the quality of the constitution of an individual according to the absence or presence in the iris of the various hereditary and acquired taints, encumbrances and defects. According to the showing in the iris of color, density, and hereditary lesions, we distinguish four types of constitutions, as shown in this illustration (Fig. 2).

It is a common thing to find hereditary and congenital signs. The iris indicates abnormal heredity not only in a general way by darkened color and by defective density, but also in a more definite way by portrayal of hereditary organic defects in the iris of the infant, as shown in these pictures. In the iris we notice in addition to the whitish lines of acute eliminative activity, nerve rings, and signs of organic lesions in the forms of ovoid or spindal shadings. In this manner we have frequently seen weak organs and parts in parents indicated in the iris of the offspring.

The color of the iris darkens with degeneration in health. Color, density, and hereditary defects together are, therefore, the indicators of hereditary, congenital and acquired tendencies toward health or disease.

The eliminative processes show in the iris of the new born infant and growing children in the form of a white star which proceeds from the pupil outward in all directions, especially in those organs where elimination is most active, as, for instance, in the digestive tract and respiratory organs. White signs are indicative of acute inflammation. When the entire organism is in a feverish condition, the eyes present a white glistening appearance commonly noticed in high fever, or, in states of great mental nervous strain.

Every acute inflammatory process is the result of a cleansing and healing effort of nature. The white clouds in the eyes indicate nature's healing forces and as the inflamed parts or organs return to normal, the white signs of inflammation disappear. The white signs and interlacing white lines are the signs of calcium and lucium, nature's only healing agents. Fig. 2, see white lines.

Congestion in any organ or part of the body reflexively gives rise to similar vaso motor changes in the corresponding organ area in the iris. For instance, when through injury or surgical treatment, muscular or other tissues have been torn, cut or broken, cross-wise the corresponding lesions in the iris run diagonally or cross-wise to the surface filaments of the iris, while lesions caused by internal inflammatory processes run parallel with the fibers of the iris.

The pathological changes from the acute to the sub-acute stages are accompanied by atrophy and sloughing of cells and tissues, and these are portrayed in the iris by atrophy of structures in the corresponding organ areas. This produces the gray and dark shades of "sub-acute lesions."

The third stage of encumbrance is caused by suppressive treatment which hindered nature in the elimination of mucus and pus. This toxic matter settles in the cells of tissues along with the drug poison and thus becomes a serious continuous irritation.

The iris shows these stages of tissue (Fig. 2, Sec. 3) degeneration by lack of vitality in the tissue which seems to dry, shrivel, and turn dark. As a result of this change the white cloud of the acute inflammatory lesion becomes intermingled with dark shadings and streaks. Examination under a high power magnifier shows the dark area more or less depressed. In the advanced stages of degeneration they deepen into holes, sometimes down to the black pigment layer.

If nature succeeds in healing the various diseased conditions of the body by formation of scar tissue, the dark signs in the iris become circumscribed and interwoven with white lines. The more perfect

the healing, the more white lines are interwoven with the dark and the more solid the white enclosures.

The fourth stage of chronic degeneration (Fig. 2, Sec. 4) of tissue is the advanced stage, or atrophy. Thorough investigation of the four stages of disease must be kept in the mind early in the study of iridology, as it is essential. Some may say there are more than four stages, but I believe it is ordinarily considered correct to speak of the four stages, which are called:

Acute
Sub-acute
Chronic
Destructive.

Acute inflammation shows as white signs. If nature is not interrupted in its healing process, the white color will gradually disappear. This is the pain stage of the encumbrance (Fig. 2, Sec. 1).

Signs seen in half acute, half chronic conditions, like asthma, etc. cause these lines to be grayish. The defects represented are of the open latent type. There is less pain at this stage (Fig. 2, Sec. 2).

Closed defects of the diseased state in which condition the pain has ceased to be so severe and under improved hygienic conditions becomes the catarrhal defect. This is one of the most common defects seen. When the pain stops, the disease is probably more dangerous, because nature is not fighting the encumbrances. The closed catarrhal defects are the dark and black signs surrounded by crooked white lines. The white lines may be slightly colored and intermingled, or cross the dark areas showing drug suppression (Fig. 2, Sec. 3).

An open catarrhal defect sign, shows the patient does not have much pain.

Black spots show loss of substance, decay of organs, or hereditary defects. In the new born, acquired defects such as those from surgery or accidents, the seriousness is judged by the depth of the lesion and its blackness. Catarrhal defects are of the first class, if the white lines of healing are over the black color of destruction. Catarrhal defects are of the second class, if the deep black color is separated by gaps and the white healing lines exist, but sparingly. Thus we see how the various stages of disease and tissue degeneration take place.

First, the white sign or acute stages, which will disappear, if properly treated, abiding by the laws of nature.

Second, the stage of suppression which throws the condition into chronic catarrhal defects, both closed and open; and step by step until we have actual loss of substance and tissue degeneration. Fig. 2, Sec. 4.

Drug signs may become of great importance to the optometrical findings and should be understood because there are various forms of drugs which cause contraction of the visual fields and dimming of vision that cannot otherwise be explained. The colors which make their appearance in the iris during the lifetime, are called the unnatural or acquired colors.

Suppression or driving back of the milk scurf first produces a yellowish coloring around the pupil; later is the blackish scurf rim on the outer edge of the iris. The other so-called children's diseases, such as measles, scarlet fever, etc., are to be regarded as subordinate forms of the milk scurf. Improper treatment of these skin diseases produces also the yellowish color around the pupil, that later is the darkened scurf rim.

The signs of scabies are sharply bordered, coarsely marked spots of the size of a prick of a pin, which may enlarge to the size of the head of a match. These spots darken in time, so that we can fairly diagnose from their color and size at what age the disease and its false treatment had occurred.

Allopathic treatment with tar, sulphur, mercury, salves, certain forms of soaps and ointments, etc., throw poisonous matter back into the system, which always settles in the weakest part of the body. These are recognized in the iris by sharply bordered red spots, etc., varying to dark brown, and getting darker in the course of years.

It is said that drugs are not assimilated by the system, but act as "foreign matter." They are enveloped with mucus (secreted by the membranes) and deposited in the various parts of the body.

The most noticeable drug signs or drug markings are caused by mercury, quinine, iodine, arsenic, phosphorus, strychnine, lead, salicylic acid, turpentine, glycerine, opium, cocain, potassium bromide, etc.

Mercury in great quantities show in the blue iris near the outer edge as a grayish white line of a metallic shine. This line looks somewhat blue in the brown eye. Mercury taken in smaller quantities produces the same signs, only in the upper part of the iris, because it is drawn first to the mucous membranes of the brain, and then to those of the respiratory system. During this time the poison produces whitish grey clouds.

Quinine shows as a distinct yellow color, which if taken in small quantities appears only in those parts of the iris corresponding to the bowels; but, if the whole body is saturated with the poison, the yellow in the iris becomes predominant, and the blue takes a greenish color while the brown eye becomes somewhat more of a pale yellow color.

Iodine gives red and yellowish red spots mostly in those parts of the iris corresponding to the stomach, kidney, and brain. These

spots are similar in color to those of the scabies, with the exception that the latter are sharply bordered, while the former gradually changes into the surrounding fields of the iris. Below the iodine spots there are seen white clouds, signs of a latent inflammation. These signs give the spots a somewhat softer color and are the missing signs if the spot is the mark of scabies.

Arsenic shows as markings similar to snow flakes in the outer part of the iris, in those parts corresponding to the limbs, the brain and the back. Arsenic causes irritation to the lacrimal glands, a symptom which is sometimes misunderstood.

Phosphorus appears as whitish grey clouds in the part of the iris corresponding to the stomach, bowels, head and limbs. These effects are similar to those of arsenic.

Strychnine gives white to whitish yellow lines around the stomach region.

Lead gives the region around the stomach in the iris a lead grey color.

Salicylic acid gives a dirty grey color to the iris. Generally begins showing in the upper part of the iris.

Creosote acts similar to that of salicylic acid, except that the covering is finer and starts its appearance from the region corresponding to the stomach, extending to the rim of the iris.

Turpentine produces rather dense grey clouds, mostly in the kidney region, in the direction of the rim of the iris.

Glycerine is not as harmful as generally believed, although it produces large white clouds in the periphery of the iris, extending to the skin, kidneys, and lungs. If taken in large quantities it is liable to obliterate the border between the iris and cornea, just the same as salicylic acid.

Opium and cocain appear as whitish grey line around the pupil.

Potassium bromide makes a white crescent in the upper half of the iris.

Vaccination in general gives a darkening of the color of the iris, which is a sign of general deterioration of the lymph and blood. The darkening begins around the pupil. Much could be said about the effect of vaccinations, but space will not permit.

Cold serums and hay fever serums, also, give distinctive changes in the iris.

So we see that a study of the iris, if properly used, may be very enlightening and that ocular diagnosis consists in discernment of the condition of the human body by observation of every minute structure of the eye; and that iridology is a scientific determination, partly anamnestic, in so far as it relates to conditions of the past, namely, hereditary disposition, sustained injuries, and morbid changes, which

take place in the body, partly diagnostic, in that it takes into account the existing symptoms; and partly prognostic in that it estimates the probable effects which eventually diseased conditions will have on the organs of the body, and endeavors to ascertain the individual's vital powers to resist diseases.

Lastly, the subject acquires a pathological significance, in that it demonstrates the value of proper eliminative therapeutics, and that suitable treatment causes distinctive changes to take place in the iris and to manifest themselves accordingly.

Time and space will not permit of further discussion. It is my hope that these remarks will increase further interest in the subject and reference to various standard publications with a view to incorporating the subject in routine examinations wherever possible.

DR. R. W. BENNETT,
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OCULAR PHYSICAL THERAPY IN ENGLAND AND AMERICA

It may be interesting to contrast the development of ocular physical therapy among optometrists in this country and in England. While the application of ocular physical therapy technic had been originated in the United States, the English optometrists do not intend to let their American cousins get ahead of them in this respect, as can be seen from the following abstract which appeared in a recent number of The Optician—the leading English optometrical publication:

"Mr. Ross-Mansell's lecture on 'Ocular Physical Therapy' attracted quite a few of the more scientific-minded opticians, and it was unfortunate that the lecturer could not deal with the subject as fully as he had intended on account of the limited time available. Nevertheless, an excellent account of the electrical principles and apparatus used in this coming technique was given by the lecturer who, in the second part of his lecture, gave some details as to the use of this technique in cases of squint and other ocular abnormalities.

"An interesting discussion on the paper revolved around the legality of opticians, using physical-therapy apparatus. The lecturer was of the opinion that opticians were within their rights in using these methods, providing they had sufficient specialized training to enable them to carry them out successfully. This view was supported

by the chairman, a well-known medical authority on physical-therapy. Some of the greatest physical-therapy practitioners in this country today were men who had had no medical training.

"Facilities for training in this technique can be undertaken by opticians who are in every way eminently suited for practicing these methods of treatment and full details can be obtained by writing to Mr. J. Ross-Mansell, c/o The Optician."

Our English contemporaries are to be complimented and congratulated. While the editor of The Optician may not, himself, be familiar with the subject of Ocular Physical Therapy, nor favor its application by optometrists as yet, he does not put any stumbling blocks in the path of this form of progress as do some of our American contemporaries who in order to gain their point resort to misquotations, mis-statements and half truths. The members of the group who oppose every new idea and every move which will tend to broaden the scope of optometry in this country disregard even the importance of being consistent. As our clear thinker and writer, Dr. J. I. Pascal, in a recent article discussing the stand of the members of this group says that "they are inconsistent, they do not know what they want, *they say one thing and do another.*" That is, they do themselves the very things they so openly oppose.

J. I. K.

BOOK NOTICES

SELECTED READINGS IN PHYSIOLOGY, by Dr. John F. Fulton, Professor of Physiology, Yale University. Published by Charles C. Thomas, Springfield, Ill. 317 pages, 60 illustrations, 1930. Price $5.00.

In the book, "Selected Readings in the History of Physiology," Fulton gives a complete historical sketch of all of the important findings and discoveries in the science of physiology from the middle of the 17th century to the present time. The several fields of physiological thought have been grouped into subjects of circulation, respiration, digestion, etc., all of which are arranged in chronological order.

The book is well illustrated, in many instances the text is accompanied by photographic reproductions of the original drawings, title pages and portraits of the investigators.

This book is of extreme interest to the student of physiology as it gives a complete historical view of the development of this science during the last four centuries, also it acquaints the reader with the leading figures who contributed much to broaden the knowledge of physiology.

J. I. K.

ANNOTATIONS AND SOCIETY PROCEEDINGS

The American Journal of Optometry is the Official Organ of the American Academy of Optometry, as well as the Organ of the Arkansas, Delaware, Indiana, Iowa, Maine, Maryland, Michigan, Minnesota, Nebraska, North Dakota, Oklahoma, Pennsylvania, South Dakota, Vermont and West Virginia Optometric Associations.

The following gentlemen have consented to supply items of interest from their respective sections, acting in the capacity of

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RETRACTION ABOUT DR. BETTS

Through an error on page 301, Volume 8, in the October issue of this Journal appeared a notice that court action was brought against the Betts Optical Company, Inc., for illegal practice of optometry. It should have been the Burts Optical Company, Inc. We are pleased to make this correction.

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COMING OPTOMETRIC MEETINGS

The Indiana Association of Optometrists will hold its annual meeting at the Sevearn Hotel, on January 10th, 11th and 12th, at Indianapolis.

The Annual Graduate Clinic of the San Francisco Society will be held in that city from November 6th to November 20th. Optometrists wishing to participate in this clinic should communicate with Dr. S. C. Marcuse, Jr., 1309 Rush Bldg., San Francisco, Calif.

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MASSACHUSETTS BOARD OF OPTOMETRY

The Massachusetts Board of Registration in Optometry will hold its fall examination on November 17th, 18th, 19th and 20th, 1931, at the State House, Boston, Mass. Applicants for the examinations are requested to have their applications on file at the office of the Secretary, Room 141, State House, at least ten days before date of examination.

* * * * * * * *

NEW STYLES IN INCONSPICUOUS EYEWEAR

NEW, DIFFERENT, IMPROVED—the One-piece Clingswell. With box studs eliminated it has new simplicity, new styling. All of Clingswell's famed resiliency in the solid gold bridge. Improved guard arm for better adjusting. The illustration of the bridge, right, tells better than words its own story of Clingswell's new beauty.

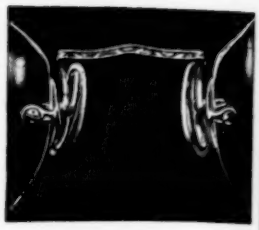
Redesigned as a mounting, the Rimless Manley bridge has a different distinctive shape and an engraving which will immediately receive the masculine approval. The bridge is rigid and sturdy with rocking pads for comfort. And good looking? Observe the closeup of the bridge.

Hy-Clingswell, Gothic Clingswell, Sovereign Rimless—mountings of accepted appeal and proved popularity—each finds a definite niche in the modern Inconspicuous Eyewear style program. They are bridge styles which the discriminating fitter knows are demanded by certain types of faces.

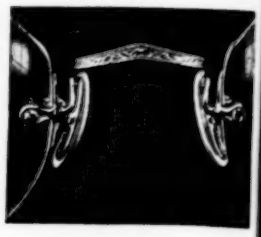
Arista Natural Gold

and

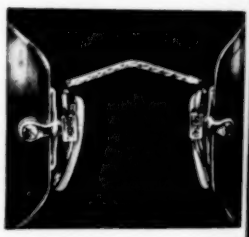
White Gold Filled



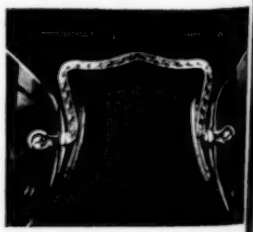
Onepiece Clingswell
Simple in design and construction—and beautiful.



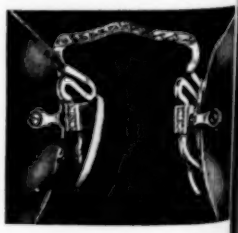
Manley Rimless
A mounting designed to meet masculine approval.



Gothic Clingswell
Unsurpassed resiliency, delicate lines and engraving.



Sovereign Rimless
A standard high bridge style, for wear everywhere.



Hy-Clingswell
Clingswell advantages in high bridge style.